







## ICE - CAVES.

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**ICE-CAVES**  
**OF**  
**FRANCE AND SWITZERLAND.**

**A NARRATIVE OF**  
  
**SUBTERRANEAN EXPLORATION.**

**BY THE**  
  
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## PREFACE.

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THE EXISTENCE of natural ice-caves at depths varying from 50 to 200 feet below the surface of the earth, unconnected with glaciers or snow mountains, and in latitudes and at altitudes where ice could not under ordinary circumstances be supposed to exist, has attracted some attention on the Continent; but little or nothing seems to be practically known in England on the subject. These caves are so singular, and many of them so well repay inspection, that a description of the twelve which I have visited can scarcely, as it seems to me, be considered an uncalled-for addition to the numerous books of travel which are constantly appearing. In order to prevent my narrative from being a mere dry record of natural phenomena, I have interspersed it with such incidents of travel as may be interesting in themselves or useful to those who are inclined to follow my steps. I have also given, from various sources, accounts of similar caves in different parts of the world.

A pamphlet on *Glacières Naturelles* by M. Thury, of Geneva, of the existence of which I was not aware when I commenced my explorations, has been of great service to me. M. Thury had only visited three glacières when he published his pamphlet in



1861, but the observations he records are very valuable. He had attempted to visit a fourth, when, unfortunately, the want of a ladder of sufficient length stopped him.

I was allowed to read Papers before the British Association at Bath (1864), in the Chemical Section, on the prismatic formation of the ice in these caves, and in the Geological Section, on their general character and the possible causes of their existence.

It is necessary to say, with regard to the sections given in this book, that, while the proportions of the masses of ice are in accordance with measurements taken on the spot, the interior height of many of the caves, and the curves of the roof and sides, are put in with a free hand, some of them from memory. And of the measurements, too, it is only fair to say that they were taken for the most part under very unfavourable circumstances, in dark caves lighted by one, or sometimes by two candles, with a temperature varying from slightly above to slightly below the freezing-point, and with no surer foot-hold than that afforded by slippery slopes of ice and chaotic blocks of stone. In all cases, errors are due to want of skill, not of honesty; and I hope that they do not generally lie on the side of exaggeration.

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## FRANCE AND SWITZERLAND.



### CHAPTER I.

#### THE GLACIÈRE OF LA GENOLLIÈRE, IN THE JURA.

IN the summer of 1861, I found myself, with some members of my family, in a small rustic *pension* in the village of Arzier, one of the highest villages of the pleasant slope by which the Jura passes down to the Lake of Geneva. The son of the house was an intelligent man, with a good knowledge of the natural curiosities which abound in that remarkable range of hills, and under his guidance we saw many strange things. More than once, he spoke of the existence of a *glacière* at no great distance, and talked of taking us to see it; but we were sceptical on the subject, imagining that *glacière* was his patois for *glacier*, and knowing that anything of the glacier kind was out of the question. At last, however, on a hot day in August, we set off with him, armed, at his request, with candles; and, after two or three hours of pine forests, and grass glades, and imaginary paths up rocky ranges of hill towards the summits of the Jura, we came to a deep natural pit, down the side of which we scrambled. At the bottom, after penetrating a few yards into a chasm in the rock, we discovered a small low cave, perfectly dark, with a flooring of ice, and a pillar of the same material in the form of a

headless woman, one of whose shoulders we eventually carried off, to regale our parched friends at Arzier. We lighted up the cave with candles, and sat crouched on the ice drinking our wine, finding water, which served the double purpose of icing and diluting the wine, in small basins in the floor of ice, formed apparently by drops falling from the roof of the cave.

A few days after, our guide and companion took us to an ice-cavern on a larger scale, which, we were told, supplies Geneva with ice when the ordinary stores of that town fail; and the next year my sisters went to yet another, where, however, they did not reach the ice, as the ladder necessary for the final drop was not forthcoming.

In the course of the last year or two, I have mentioned these glaciers now and then in England, and no one has seemed to know anything about them; so I determined, in the spring of 1864, to spend a part of the summer in examining the three we had already seen or heard of, and discovering, if possible, the existence of similar caves.

The first that came under my notice was the Glacière of La Genollière; and, though it is smaller and less interesting than most of those which I afterwards visited, many of its general features are merely reproduced on a larger scale in them. I shall therefore commence with this cave, and proceed with the account of my explorations in their natural order. It is probable that some of the earlier details may seem to be somewhat tedious, but they are necessary for a proper understanding of the subject.

La Genollière is the *montagne*, or mountain pasturage and wood, belonging to the village of Genollier, an ancient priory of the monks of S. Claude.\* The cave itself lies at

\* In this neighbourhood, the *montagne* of any *commune* is represented by the feminine form of the name of the village: thus, *L'Arzière* is the *montagne* of Arzier, and *La Bassine* of Bassin. This has a curious effect in the case of some villages—such, for instance, as S. Georges—one of the landmarks of

no great distance from Arzier—a village which may be seen in profile from the Grand Quai of Geneva, ambitiously climbing towards the summit of the last slope of the Jura. To reach the cave from Geneva, it would be necessary to take train or steamer to Nyon, whence an early omnibus runs to S. Cergues, if crawling up the serpentine road can be called running; and from S. Cergues a guide must be taken across the Fruitière de Nyon, if anyone can be found who knows the way. From Arzier, however, which is nine miles up from Nyon, it was not necessary to take the S. Cergues route; and we went straight through the woods, past the site of an old convent and its drained fish-pond, and up the various rocky ridges of hill, with no guide beyond the recollection of the previous visits two and three years before, and a sort of idea that we must go north-west. As it was not yet July, the cows had not made their summer move to the higher châlets, and we found the mountains uninhabited and still.

The point to be made for is the upper Châlet of La Genollière, called by some of the people *La Baronne*,\* though the district map puts La Baronne at some distance from the site of the glacière. We had some difficulty in finding the châlet, and were obliged to spread out now and

the district between the lakes of Joux and Geneva being the *Châlet de la S. Georges*, a grammatical anomaly which puzzles a stranger descending the southernmost slope of the Jura from the Asile de Marchairuz. This law of formation is not universal; for the *montagnes* of Rolle and S. Livres are called the *Pré de Rolle* and the *Pré de S. Livres*, while the *Fruitière de Nyon* is the rich upland possession of the town of that name.

\* Probably a relic of the time when the earlier Barons of Coppet possessed this district. The families of Grandson, Lesdiguières, and Dohna successively held the barony; and in later times the title *de Coppet* hid a name more widely known, for on the Châlet of *Les Biolles*, some distance to the east of La Baronne, the name of *Auguste de Staël de Holstein de Coppet* is carved, after the fashion of Swiss châlets. This was Madame de Staël's son, who built Biolles in 1817; it was afterwards sold to the commune of Nyon, and finally purchased by Arzier two or three years ago.



then, that each might hunt a specified portion of the wood or glade for signs to guide our further advance, enjoying meanwhile the lilies of the mountain and lilies of the valley, and fixing upon curious trees and plants as landmarks for our return. In crossing the last grass, we found the earliest vanilla orchis (*Orchis nigra*) of the year, and came upon beds of moonwort (*Botrychium Lunaria*) of so unusual a size that our progress ceased till such time as the finest specimens were secured.

Some time before reaching this point, we caught a glimpse of a dark speck on the highest summit in sight, which recalled pleasantly a night we had spent there three years before for the purpose of seeing the sun rise.\* My sisters had revisited the Châlet des Chèvres, which this dark speck represented, in 1862, and found that the small chamber in which we had slept on planks and logs had become a more total ruin than before, in the course of the winter, so that it is now utterly untenable.

From Arzier to the Châlet of La Genollière, would be about two hours, for a man walking and mounting quickly, and never losing the way; and the glacière lies a few minutes farther to the north-west, at an elevation of about 2,800 feet above the lake, or 4,000 feet above the sea.† A rough mountain road, leading over an undulating expanse of grass, passes narrowly between two small clumps of trees, each surrounded by a low circular wall, the longer diameter of the enclosure on the south side of the road being 60 feet. In this enclosure is a natural pit, of which the north side is a sheer rock, of the ordinary limestone of the Jura, with a chasm almost from the top; while the south side is less steep, and affords the means of scrambling down to the

\* 'Cornhill Magazine,' June 1863, 'How we slept at the Châlet des Chèvres.'

† This is only a guess, made from a comparison with the ascertained heights of neighbouring points.

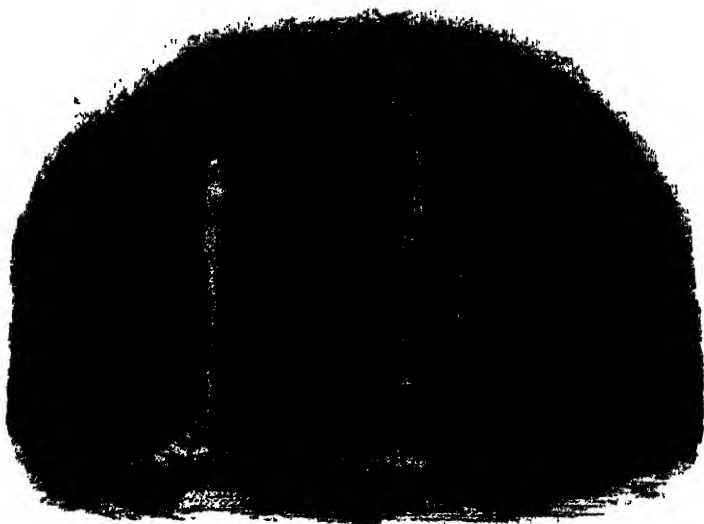
bottom, where a cave is found at the foot of the chasm, passing under the road. The floor of this small but comparatively lofty cave is 52 feet below the surface of the earth, and slopes away rapidly to the west, where, by the help of candles, the rock which forms the wall is seen to stop short of the floor, leaving an entrance 2 or 3 feet high to an inner cave—the glacière. The roof of this inner cave rises slightly, and its floor falls, so that there is a height of about 6 feet inside, excepting where a large open fissure in the roof passes high up towards the world above. At one end, neither the roof nor the floor slopes much, and in this part of the cave the height is less than 3 feet.

It would be very imprudent to go straight into an ice-cave after a long walk on a hot summer's day, so we prepared to dine under the shade of the trees at the edge of the pit, and I went down into the cave for a few moments to get a piece of ice for our wine. My first impression was that the glacière was entirely destroyed, for the outer cave was a mere chaos of rock and stones; but, on further investigation, it turned out that the ruin had not reached the inner cave. In our previous visit we had noticed a natural basin of some size and depth among the trees on the north side of the road, and we now found that the chaos was the result of a recent falling-in of this basin; so that from the bottom of the first cave, standing as it were under the road, we could see daylight through the newly-formed hole.

The total length of the floor of the inner cave, which lies north-east and south-west, is 51 feet; and of this floor a length of about 37 feet was more or less covered with ice, the greatest breadth of the ice being within an inch or two of 11 feet. Excepting in the part of the cave already mentioned as being less than 3 feet high, we found the floor not nearly so dry, nor so completely covered with ice, as when we first saw the glacière, three years before, in

the middle of an exceptionally hot August. Under the low roof all was very dry, though even there the ice had not an average thickness of more than 8 inches. It may be as well to say, once for all, that the ice in these caves is never found in a sheet on a pool of water; it is always solid, forming the floor of the cave, filling up the interstices of the loose stones, and rising above them, in this case with a surface perfectly level.

We found four principal columns of ice, three of which, in the loftiest part of the cave, are represented in the accompanying engraving: I call them three, and not



ICE-COLUMNS IN THE GLACIÈRE OF LA GENOLLIÈRE.

two, because the two which unite in a common base proceeded from different fissures. The line of light at the foot of the rock-wall is the only entrance to the glacière. The lowest column was  $11\frac{1}{2}$  feet high and  $1\frac{1}{2}$  feet broad, not more than 6 inches thick in the middle, half-way up, and flattened symmetrically so as to

be comparatively sharp at the edges, like a huge double-edged sword. It stood clear of the rock through its whole height, but scarcely left room between itself and the wall of the cave for a candle to be passed up and down. The other two columns shown in the engraving poured out of fissures in the rock, streaming down as cascades, the one being  $13\frac{1}{2}$  and the other 15 feet high; and when we tied a candle to the end of an alpenstock, and passed it into the fissures, we found that the bend of the fissures prevented our seeing the termination of the ice. An intermittent disturbance of the air in these fissures made the flame flicker at intervals, though generally the candle burned steadily in them, and we could detect no current in the cave. The fourth column was in the low part of the cave, and we were obliged to grovel on the ice to get its dimensions: it was  $3\frac{1}{4}$  feet broad and  $4\frac{1}{3}$  feet high, the roof of the cave being only  $2\frac{3}{4}$  feet high; and it poured out of the vertical fissure like a smooth round fall of water, adhering lightly to the rock at its upper end like a fungus, and growing out suddenly in its full size. This column was dry, whereas on the others there were abundant symptoms of moisture, as if small quantities of water were trickling down them from their fissures, though the fissures themselves appeared to be perfectly dry.

In one of the fissures there was a patch of what is known as sweating-stone,\* with globules of water oozing out, and standing roundly upon it: the globules were not frozen. This stone was exceedingly hard, and defied all our efforts to break off a specimen, but at last we got two small pieces, hard and heavy, and wrapped them in paper; ten weeks after, we found them of course quite dry, and broke them easily, small as they were, with our fingers. The fissure

\* The patois of Vaud has a prettier name for this kind of stone—*la scax* (or *scax*) *qui plliou*, the weeping-stone.

from which the shortest of the four columns came was full of gnats, as were also several crevices in the walls of the cave, especially in the lowest part; and we found a number of large red-brown flies,\* nearly an inch long, running rapidly on the ice and stones, after the fashion of the flies with which trout love best to be taken. The central parts of the cave, where the roof is high, were in a state provincially known as 'sloppy,' and drops of water fell now and then from above, either splashing on wet stones, or hollowing out basins in the remaining ice, or, sometimes, shrewdly detecting the most sensitive spot in the back of the human neck. We placed one of Casella's thermometers on a piece of wood on one of the wet stones, clear of the ice, and it soon fell to 34°. Probably the temperature had been somewhat raised by the continued presence of three human beings and two lighted candles in the small cavern; and, at any rate, the cold of two degrees above freezing was something very real on a hot summer's day, and told considerably upon my sisters, so that we were compelled to beat a retreat,—not quite in time, for one of our party could not effect a thaw, even by stamping about violently in the full afternoon sun.

While we were in the cave, we noticed that the surfaces of the columns were covered by very irregular lines, marked somewhat deeply in the ice, and dividing the surface into areas of all shapes, a sort of network, with meshes of many different shapes and sizes. These areas were smaller towards the edges of the columns; the lines containing them were not, as a rule, straight lines, and almost baffled our efforts to count them, but, to the best of my belief, there were meshes with three, four, and up to eight sides. The column which stood clear of the rock was composed of very

\* I brought one of these to England, and am told that it is the *Stenophylax heteroglyphicus* of Stephens, or something very like that fly.

limpid ice, without admixture of air ; but the cascades were interpenetrated by veins of looser white ice, and, where the white ice came, the surface lines seemed to disappear. As we sat on the grass outside, arranging our properties for departure, my attention was arrested by the columnar appearance of the fractured edge of the block of ice which we had used at luncheon. It was about 5 inches thick, and had formed part of a stalagmite whose horizontal section, like that of the free column, would be an ellipse of considerable eccentricity ; and, on examination, it turned out that the surface areas, which varied in size from a large thumb-nail to something very small, were the ends of prisms reaching through to the other side of the piece of ice, at any rate in the thinner parts, and presenting there similar faces. Not only so, but the prisms could be detached with great ease, by using no instrument more violent than the fingers ; while the point of a thin knife entered freely at any of the surface lines, and split the ice neatly down the sides of the prisms. When one or two of the sides of a prism were exposed, at the edge of the piece of ice, the prism could be pushed out entire, like a knot from the edge of a piece of wood. In some cases there seemed to be capillary fissures coincident with the lines where several sides of prisms met. Considering the shape of the whole column, it is clear that the two ends of each prism could not be parallel ; neither was one of the ends perfectly symmetrical with the other, and I do not think that the prisms were of the nature of truncated pyramids. On descending again, I found that the columns were without exception formed of this prismatic ice, either in whole, as in the clear column, or in part, as where limpid prisms existed among the white ice which ran in veins down the cascades. In the free vertical column the prisms seemed to be deposited horizontally, and in the thicker parts they

did not pass clear through. We carried a large piece of ice down to Arzier in a botanical tin, and on our arrival there we found that all traces of external lines had disappeared.

This visit to the glacière was on Saturday, and on the following Monday I determined to go up alone, to take a registering thermometer, and leave it in the cave for the night; which, of course, would entail a third visit on the next day. Monday brought a steady penetrating rain, of that peculiar character which six Scotch springs had taught me to describe as 'just a bit must;' while in the higher regions the fog was so hopeless, that a sudden lift of the mist revealed the unpleasant fact that considerable progress had been made in a westerly direction, the true line being north-west. Instead of the rocks of La Genollière, the foreground presented was the base of the Dôle, and the chasm which affords a passage from the well-known fortress of Les Rousses into Vaud. There was nothing for it but to turn in the right direction, or attempt to do so, and force a way through the wet woods till something should turn up. This something took the form of a chalet; but no amount of hammering and shouting produced any response, and it was only after a forcible entrance, and a prolonged course of interior shouting, that a man was at length drawn. He said that he had been asleep—and why he put it in a past tense is still a mystery—and could give no idea of the direction of the chalet on La Genollière, beyond a vague suggestion that it was somewhere in the mist; a suggestion by no means improbable, seeing that the mist was ubiquitous. One piece of information he was able to give, and it was consoling: I was now, it seemed, on the Fruitière de Nyon, and therefore the desired chalet could not be far off, if only a guide could be found. On the whole, he thought that a guide could

not be found ; but there were men in the châlet, and I might go up the ladder with him and see what could be done. He led to a chamber with a window of one small pane, dating apparently from the first invention of glass, and never cleaned since. An invisible corner of the room was appealed to ; but the voice which resided there, and seemed like everything else to be asleep, pleaded dreamily a total ignorance of the whereabouts of the châlet in question. Just as, by dint of steady staring through the darkness, an indistinct form of a mattress, with a human being reclining thereon, began to be visible, another dark corner announced that this new speaker had heard of a *p'tit sentier* leading to the châlet, but knew neither direction nor distance. Here the space between the two corners put in a word ; and, as the darkness was now becoming natural, seven or eight mattresses appeared, ranged round the room, some holding one, some two men, most of whom were sitting up on end with old caps on, displaying every variety of squalor. The voice which had spoken last declared that the distance was three-quarters of an hour, and that if the day were clear there would be no difficulty in reaching the châlet ; as it was, the man would be very glad to try.

A change of cap was the only dressing necessary for the volunteer, and we faced the fog and rain, which elicited from him such a disgraceful amount of swearing, that it was on all accounts well when the rain ceased for a few minutes, the mists rolled off, and the clouds lifted sufficiently to betray the surface of the Lake of Geneva, luxuriating in the clear warmth of an early summer's day, and making us shiver by the painful contrast which our own altitude presented. The deep blue of the lake brought to mind the story of the shepherd of Gessenay (Saanen), of whom it is told that when he was passing the hills with



some friends for a first visit to Vevey, and came in sight of the lake, which he had never seen before, he turned and hurried home incontinent, declaring that he would not enter a country where the good God had made the blue sky to fall and fill the valleys.

In this bright interval we came upon a magnificent fox, and the peasant's impulse was, 'Oh, for a good gun!' an exclamation which would have sounded horrible to English ears, if I had not been previously broken in to it by an invitation from a Scotch gamekeeper to a fox-hunt, when he promised an excellent gun, and a *stance* which the foxes were sure to pass.

The rain now came on again, and the guide thought he had had plenty of it, and must return for the afternoon milking; and just then, as good luck would have it, we stumbled upon an immense clump of nettles which had been one of our landmarks two days before, so that he was no longer necessary, and we said affectionate adieux.

The glacière was in a state of ruin. Only the right-hand column, not speaking heraldically, was standing, the others lying in blocks frozen hard together on the ground. The column which still stood was much shrunken, and seemed too small for its fissure, the sides of which it scarcely touched. The wind blew down the entrance slope so determinedly, that a candle found it difficult to live at the bottom of the first cave; and a portion of the current blew into the glacière, and in its sweep exactly struck the fallen columns, the edges of which were already rounded by thaw. Much of this must be attributed to the recent opening of the second shaft (p. 5), which admits a thorough draught through the first cave, and so exposes the glacière to currents of warmer air; and I should expect to find that in future the ice will disappear from that part

of the cave every summer,\* whereas in 1861 we found it thick and dry (excepting a few small basins containing water) and evidently permanent, in the middle of a very hot August. The low part of the cave was so completely protected from the current, that the candle burned there quite steadily for an hour and a half: still, like the others, the column at that end of the glacière was broken down, and it therefore became necessary to attribute its fall to some other agency than the current of external air. There had been a very large amount of rain, and the surface of the rock in the fissures was evidently wet; so I have no doubt that the filtering through of the warm rain-water had thawed the upper supports of the ice-cascades, and then, owing to their slightly inclined position, the pedestal had not provided sufficient support, and so they had fallen. One of them, perhaps, had brought down in its fall the free column, which had stood two days before on its own base, without any support from the rock. Very probably, too—indeed, almost certainly,—the fall of the large mass of rock, which once formed the bottom of the basin on the north side of the road, has affected the old-established fissures, by which rain-water has been accustomed to penetrate in small quantities to the glacière, so that now a much larger amount is admitted. On this account, there will probably be a great diminution of the ice in the course of future summers, though the amount formed each winter may be greater than it has hitherto been. Constant examination of other columns and fissures has convinced me, that, before the end of autumn, the majority of the glacières will have lost all the columns which depend upon the roof for a part of their support, or spring from fissures in the wall; whereas those which are true stalagmites, and

\* Since writing this, I have been told that some English officers who visited the cave in the August of 1864 found no ice in any part.

are self-supporting, will have a much better chance of remaining through the warm season, and lasting till the winter, and so increasing in size from year to year. Free stalagmites, however, which are formed under fissures capable of pouring down a large amount of water on the occasion of a great flood of rain, must succumb in time, though not so soon as the supported columns.

A curious appearance was presented by a small free stalagmite in the retired part of the cave. The surface of the stalagmite was wet, from the drops proceeding from a fissure above, and was lightly covered in many parts with a calcareous deposit, brought down from the fissures in the roof by the water filtering through. The stalagmite was of the double-edged-sword shape, and the limestone deposit collected chiefly at one of its edges, the edge nearer to that part of the cave where thaw prevailed; so that the real edge was a ridge of deposit beyond the edge of the ice.\* Patches of limestone paste lay on many parts of the ice-floor.

In the loftier part of the cave, water dropped from the roof to so large an extent, that ninety-six drops of water in a minute splashed on to a small stone immediately under the main fissure. This stone was in the centre of a considerable area of the floor which was clear of ice; and it struck me that if the columns were formed by the freezing of water dropping from the roof, there ought to have been at some time a large column under this, the most plentiful source of water in the cave. Accordingly, I found that the edge of the ice round this clear area was much thicker than the rest of the ice of the floor, and was evidently the remains of the swelling pedestal of a column which had been about 12 feet in circumference. This departed column may account for a fact which I discovered in

\* See also p. 231.

another glacière, and found to be of very common occurrence, viz., that in large stalagmites there is a considerable internal cavity, extending some feet up from the ground, and affording room even for a man to walk about inside the column. When the melted snows of spring send down to the cave, through the fissures of the rock, an abundance of water at a very low temperature, and the cave itself is stored with the winter's cold, these thicker rings of ice catch first the descending water, and so a circular wall, naturally conical, is formed round the area of stones; the remaining water either running off through the interstices, or forming a floor of ice of less thickness, which yields to the next summer's drops. In the course of time, this conical wall rises, narrowing always, till a dome-like roof is at length formed, and thenceforth the column is solid. Of course, the interior cannot be wholly free from ice; and it will be seen from the account of one of these cavities, which I explored in the Schafloch, that they are decked with ice precisely as might be expected.\* Another possible explanation of this curious and beautiful phenomenon will be given hereafter.†

The temperature was half a degree lower than when there were three of us in the cave two days before. I deposited one of Casella's registering thermometers, on wood, on a stone in that part of the floor which was free from ice, though there was ice all round it at some little distance. The thermometer was well above the surface of the ice, and was protected from chance drops of water from the roof.

The next morning I started early\* from Arzier, having an afternoon journey in prospect to the neighbourhood of another glacière, and was accompanied by Captain Douglas Smith, of the 4th Regiment. On our way to La Genollière,

\* P. 145.

† P. 301.

we came across the man who had served as guide the day before, and a short conversation respecting the glacière ensued. He had only seen it once, many years before, and he held stoutly to the usual belief of the peasantry, that the ice is formed in summer, and melts in winter; a belief which everything I had then seen contradicted. His last words as we parted were, '*Plus il fait chaud, plus ça gèle;*' and, paradoxical as it may appear, I believe that some truth was concealed in what he said, though not as he meant it. Considering that his ideas were confined to his cattle and their requirements, and that water is often very difficult to find in that part of the Jura, a *hot* summer would probably mean with him a *dry* summer, that is, a summer which does not send down much water to thaw the columns in the cave. Extra heat in the air outside, at any season, does not, as experience of these caves proves abundantly, produce very considerable disturbance of their low temperature, and so summer water is a much worse enemy than extra summer heat; and if the caves could be protected from water in the hot season, the columns in them would know how to resist the possible—but very small—increase of temperature due to the excess of heat of one summer above another. And since the eye is most struck by the appearance of the stalagmites and ice-cascades, it may well be that the peasants have seen these standing at the end of an unusually hot and dry summer, and have thence concluded that hot summers are the best time for the formation of ice. Of course, at the beginning of the winter after a hot summer, there will be on these terms a larger nucleus of ice; and so it will become true that the hotter the year, the more ice there will be, both during the summer itself and after the following winter.

The further process of the formation of ice will be this:—the colds of early winter will freeze all the water that

may be in the glaciers from the summer's thaw, in such caves as do not possess a drainage, and then the frost will have nothing to occupy itself upon but the ice already formed, for no water can descend from the frost-bound surface of the earth.\* As soon as the snow begins to melt to so great a degree that the fissures are opened up once more, the extremely cold water resulting therefrom will descend through the limestone into a cave perfectly dry, and filled with an atmosphere many degrees below the freezing point, whose frost-power eagerly lays hold of every drop of water which does not make its escape in time by the drainage of the cave. Thus the spring months will be the great time of the formation of ice, and also of the raising of the temperature from some degrees below freezing to the more temperate register at which I have generally found it, viz., rather above than below  $32^{\circ}$ . Professor Tyndall very properly likens the external atmosphere to a ratchet-wheel, from its property of allowing the passage of hot rays down to the surface of the earth, and resisting their return: it may equally be so described on other grounds, inasmuch as the cold and heavy atmosphere will sink in the winter into the pits which lead to glaciers, and will refuse to be altogether displaced in summer by anything short of solar radiation.

We found the one column of the previous day still

\* It is possible that the freezing of the surface may play a curious part in the phenomena of the spring season in such caves. Supposing the surface to be completely frost-bound, all atmospheric pressure will be removed from the upper surface of the water in the long fissures, and thus water may be held in suspension, in the centre of large masses of fissured rock, during the winter months. The first thorough thaw will have the same effect as the removal of the thumb from the upper orifice in the case of the hand-shower-bath; and the water thus rained down into the cave will have a temperature sufficiently high to destroy some portion of the cold stored up by the descent of the heavy atmosphere of winter, or at least to melt out the ice which may have blocked up the lower ends of the fissures.

standing, though evidently in an unhappy state of decay. The sharpness of its edges was wholly gone, and it was withered and contorted; there were two cracks completely through it, dividing it into three pieces 4 or 5 feet long, which were clearly on the point of coming down. Externally, the day was fine and warm, and so we found the cave comparatively dry, only one drop falling in a minute on to the stone where ninety-six had fallen in the same time the day before. The thermometer registered  $32^{\circ}$  as the greatest cold of the night, and still stood at that point when we took it up.

We spent some little time in exploring the neighbourhood of the pits, in order to find, if possible, the outlet for the drainage, but the ground did not fall away sufficiently for any source from so low an origin to show itself. The search was suggested by what I remembered of the Glacière of S. Georges three years before, where the people believe that a small streamlet which issues from the bottom of a steep rock, some distance off, owes its existence to the glacière.

## CHAPTER II.

## THE GLACIÈRE OF S. GEORGES, IN THE JURA.

THE best way of reaching this glacier from Geneva would be to take the steamer to Rolle, or the train to one of the neighbouring stations, between Geneva and Lausanne, and thence pass up the slope of the Jura by the road which leads through Gimel. For the train, the Allaman station would be the most convenient, as an omnibus runs from Allaman to Aubonne, where the poste for Gimel may be caught. But from Arzier there is a short cut of less than two hours along the side of the hills, leaving that village by a deep gorge not unfitly named *L'Enfer*, and a dark wood which retains an odour of more savage bygone times in its name of the 'Bear's Wood,' as containing a cavern where an old bear was detected in the act of attempting to winter.\*

The village of S. Georges has very respectable accommodation for a single traveller, *au Cavalier*. The common day-room will be found untenable by most Englishmen, however largely they may delight in rough quarters; but there is a double-bedded room at the end of a bricked passage upstairs, which serves well for bedroom and sitting-room in one. The chief drawback in this arrangement is,

\* On our previous visit, in 1861, we passed from Arzier through Longirod and Marchissy, stopping to measure and admire the huge lime-tree in the churchyard of the latter village. Our Swiss companion on that occasion was anxious that we should carry home some ice from the cave; and as the communal law forbade the removal of the ice by strangers, he hunted up a cousin in Marchissy, and sent him with a *hotte* across country, while we went innocently by the ordinary route through S. Georges. The cousin, however, contrived to lose himself in the woods, and we never heard of him again.



Autumn appears to be the usual time for cutting the ice, when it is carried from the cave on men's backs as far as the commencement of the rough mountain-road, and is there packed on chars, and so conveyed to the nearest railway station. Renaud had worked in the cave for two years, and asserted that they did not choose the night for carrying the ice down to the station, and did not even care to choose a cool day. He believed that, in the autumn of 1863, they loaded two chars a day for fifteen days, and each char took from 40 to 50 quintaux; the quintal containing 50 kilos, or 100 livres.\* In Professor Pictet's time (1822) this glacière supplied the Hospital of Geneva, whose income depended in part on its privilege of *revente* of all ice sold in the town, with 25 quintaux every other day during the summer. In my anxiety to learn the exact amount of ice now supplied by the glacière, I determined to find out the *fermier*; but Renaud could tell nothing of him beyond the fact that he lived in Geneva, which some promiscuous person supplemented by the information that his name was Boucqueville, and that he had something to do with comestibles. On entering upon a hunt for M. Boucqueville a fortnight later, it turned out that no one had heard of such a person, and the Directory professed equal ignorance; but, under the head of 'Comestibles,' there appeared a Gignoux-Bocquet, No. 34, Marché. Thirty-four, Marché, said, yes—M. Bocquet—it was quite true: nevertheless, it was clear that monsieur meant Sebastian aîné, on the Molard. The Molard knew only a younger Sebastian, but suggested that the right man was probably M. Gignoux-Chavaz, over the way; and when it was objected that Gignoux-Bocquet, and not Gignoux-Chavaz, was the name, the Molard replied that it made no matter,—Chavaz or Bocquet, it was all the same. When

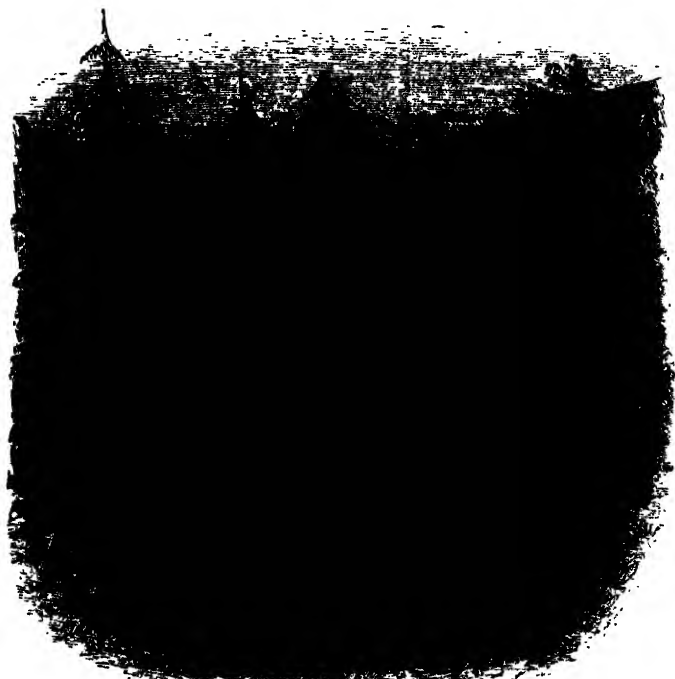
\* For further details on this point see pages 54 and 83.

M. Gignoux-Chavaz was found, he said that he certainly was a man who had something to do with a *glacière*, but, instead of farming the *Glacière* of S. Georges, he had only bought a considerable quantity of ice two years ago from the *Glacière* of S. Livres, and he did not believe that the *fermier* of S. Georges lived in Geneva. Part of the confusion was due to the custom of placing a wife's maiden name after her husband's name: thus Gignoux-Chavaz implies that a male Gignoux has married a female Chavaz; and when a Swiss marries an English lady with a very English name, the result in the Continental mouth is sufficiently curious.

On arriving at the entrance to the *glacière*, the end of a suggestive ladder is seen under the protecting trunks; and after one or two steps have been taken down the ladder, the effect of the cave below is extremely remarkable, the main features being a long wall covered thickly with white ice in sheets, a solid floor of darker-coloured ice, and a high pyramid of snow reaching up towards the uncovered hole already spoken of. The atmosphere of the cave is damp, and this causes the ladders to fall speedily to decay, so that they are by no means to be trusted: indeed, an early round gave way under one of my sisters, when they visited the cave with me in 1861, and suggested a clear fall of 60 feet on to a cascade of ice.\* There are three ladders, one below the other, and a hasty measurement gave their lengths as 20, 16, and 28 feet. The rock-roof is only

\* These ladders have at best but little stability, as they consist of two uprights, careless about the coincidence of the holes, with bars poked loosely through and left to fall out or stay in as they choose, the former being the prevailing choice. One of the ladders happened to be firmer than the generality of its kind; but, unfortunately, its legs were of unequal lengths, and so it turned round with one of my sisters, leaving her clinging like a cat to the under side. When the bars are sufficiently loose, a difference of a few inches in the lengths of the legs is not of so much importance.

a few feet thick in the neighbourhood of the hole of entrance.

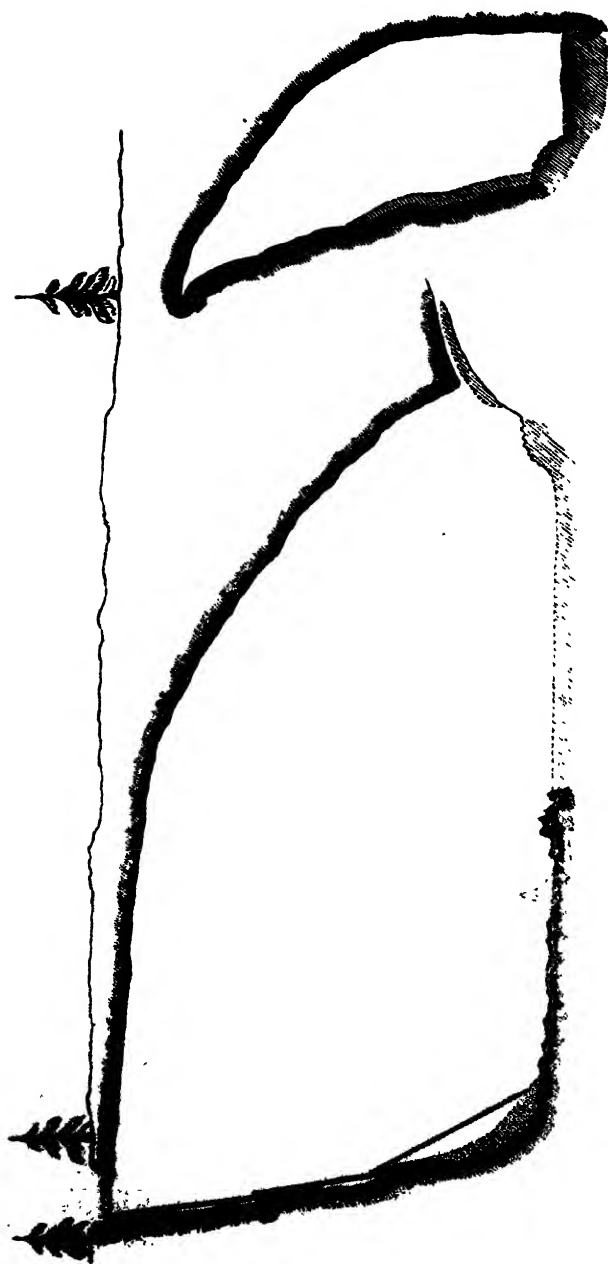


ENTRANCE TO THE GLACIÈRE OF S. GEORGES.

The total length of the cave is 110 feet, lying N.E. and S.W., in the line of the main chain of the Jura. The lowest part of the floor is a sea of ice of unknown depth, 45 feet long by 15 broad; and Renaud tried my powers of belief by asserting that in 1834 the level of this floor was higher by half the height of the cave than now: a statement, however, which is fully borne out by Professor Pictet's measurements in 1822, when the depth of the glacière was less than 30 feet. Indeed, the floor had sunk considerably since my previous visit, when it was all at the same level down to the further end of the cave; whereas

now, as will be seen in the section, there was a platform of stones resting on ice at that end. There are two large fissures passing into the rock, one only of which can be represented in the section, and these were full of white ice, not owing its whiteness apparently to the admixture of air in bubbles, but firm and compact, and very hard, almost like porcelain. Small stalactites hung from round fissures in the roof, formed of the same sort of ice, and broken off short, much as the end of a leaden pipe is sometimes seen to project from a wall. With this exception, there was no ice hanging from the roof, though there were abundant signs of very fine columns which had already yielded to the advancing warmth: one of these still remained, in the form of broken blocks of ice, in the neighbourhood of the open hole in the roof, immediately below which hole the stones of the floor were completely bare, and the thermometer stood at  $50^{\circ}$ . At the far end of the cave, the thermometer gave something less than  $32^{\circ}$ ; a difference so remarkable, at the same horizontal level, that I am inclined to doubt the accuracy of the figures, though they were registered on the spot with due care. The uncovered hole, it must be remembered, is so large, and so completely open, that the rain falls freely on to the stones on the floor below.

By far the most striking part of this glacière is the north-west wall, which is covered with a sheet of ice 70 feet long, and 22 feet high at the highest part: in the neighbourhood of the ladders, this turns the corner of the cave, and passes up for about 9 feet under the second ladder. The general thickness of the sheet is from a foot to a foot and a half; and this is the chief source from which the *fermier* draws the ice, as it is much more easily quarried than the solid floor. Some of my friends went to the cave a few weeks after my visit, and found that the whole sheet had been pared off and carried away.



VERTICAL SECTION OF THE GLACIÈRE OF S. GEORGES.

On some parts of the wall the sheet was not completely continuous, being formed of broad and distinct cascades, connected by cross channels of ice, and uniting at their upper and lower ends, thus presenting many curious and ornamental groupings. On cutting through this ice, it was found not to lie closely on the rock, a small intermediate space being generally left, almost filled with minute limestone particles in a very wet state; and the whole cavern showed signs of more or less thaw.

It was natural to examine the structure of the ice in this glacière, after what we had observed on La Genollière. The same prismatic structure was universal in the sheet on the wall, and in the blocks which lay here and there on the floor and formed the sole remains of former columns. It was to be observed also in many parts of the ice-floor itself. The base of one large column still remained standing in its original position, and its upper end presented a tolerably accurate horizontal section of the column. The centre was composed of turbid ice, round which limpid prisms were horizontally arranged, diverging like the feathers of a fan; then came a ring of turbid ice, and then a second concentric ring of limpid prisms, diverging in the same manner as those which formed the inner ring. There were in all three or four of these concentric rings, the details showing a considerable amount of confusion and interference: the general law, however, was most evident, and has held in all the similar columns which I have since examined in other glacières. The rings were not accurately circular, but presented rather the appearance of having been formed round a roughly-fluted pillar on an elliptical base.

The examination of the ice on the wall gave some curious results. The horizontal arrangement of the prisms, which we had found to prevail in vertical columns, was

here modified to suit the altered conditions of the case, and the axes of the prisms changed their inclination so as to be always perpendicular to the surface on which the ice lay, as far as could be determined by the eye. Thus, in following the many changes of inclination of the wall, the axes of the prisms stood at many different angles with the vertical, from a horizontal position where the wall chanced to be vertical, to a vertical position on the horizontal ledges of the rock. The extreme edges, too, of the ice, presented a very peculiar appearance. The general thickness, as has been said, varied from a foot to a foot and a half; and this diminished gradually along horizontal lines, till, at the edges of the sheet, where the ice ceased, it became of course nothing. The extreme edge was formed of globular or hemispherical beads of ice, like the freezing of a sweating-stone, lying so loosely on the rock that I could sweep them off in detail with one hand, and catch them with the other as they fell. Passing farther on towards the thicker parts of the ice, these beads stood up higher and higher, losing their roundness, and becoming compressed into prisms of all shapes, in very irregular imitation of the cellular tissue in plants, the axes of the prisms following the generally-observed law. There seems to be nothing in this phenomenon which cannot be accounted for by the supposition of gradual thaw of small amount being applied to a sheet of prismatic ice.

One fact was remarkable from its universal appearance. Wherever an incision was made in this sheet of ice, the prisms snapped off at the depth of an inch, and could be mowed down like corn by means of a stout knife. Although they broke naturally at this constant depth, and left a surface of limpid ice without any signs of external or internal division, still the laminæ obtained by chiselling this lower surface carefully, broke up regularly into the

shapes to be expected in sections of prisms cut at right angles to the axis. The roughness of my instruments made it impossible to discover how far this extended, and whether it ceased to be the case at any given depth in the ice.

The sea of ice on the floor was in a very wet state at the surface, being at a lower level than the stones on to which the rain from the open hole fell; and here the prismatic structure was not apparent to the eye, nor do I know whether it existed at all. In the Glacière of La Genollière I carried a large block of perfectly prismatic ice into the outer cave, where it was exposed to the free currents of air passing from the pit of entrance to the hole newly opened by the falling in of the ground; and, two days after, the external lines were scarcely perceptible, while on the occasion of our third visit I found that they had entirely disappeared, and the whole block was rapidly following their example. This disappearance of the surface-lines under the action of atmospheric thaw is probably the same thing as their absence when the flooring of ice is thinly covered with water. Wherever the flooring rose slightly towards the edges of the sea of ice, the usual structure appeared again.

There were no currents of air in the cave, the candles burning steadily through the whole time of our visit. Excepting for the purpose of detecting disturbance in the air, there is no need of candles, as the two holes in the roof supply sufficient light. Some account of the careful observations made here by M. Thury, at different seasons of the year, will be found in other parts of this book. We passed, on our return, by the source of water which springs from the foot of a rock at some distance from the glacière, and is supposed to form the outlet for the drainage of the cave; but it is difficult to understand how this



can be the case, considering the form and character of the intervening ground.

The two ice-caves so far described are the least interesting of all that I have visited; but a peasant informed me, a day or two after, that if we had penetrated to the back of the pyramid of snow which lay half under the open hole, being the remains of the large collection which is formed there in the winter, we might have found a deep pit which is sometimes exposed by the melting of the snow. He had some idea that its depth was 30 feet a few years ago, and that its sides were solid ice. I shall have occasion to mention such pits in another glacière; if one does exist here, it has probably been quarried in the ice by the drops from the hole in the roof, and there might be some interest attached to an attempt to investigate it.\*

We reached S. Georges again in a wretched state of wet and cold, and Renaud went off to bed, and imbibed abundant and super-abundant kirsch,—at least, when drawn thence the next morning, his manner left no doubt about either the fact or the abundance of the potations overnight. Warned by many experiences, I had gone no nearer to a specification of the bill of fare than a vague suggestion that *quelque chose* must be forthcoming, with an additional stipulation that this must be something more than mere onions and fat. The landlady's rendering of *quelque chose* was very agreeable, but, for the benefit of future diners *au Cavalier*, it is as well to say that those who do not like anisette had better make a private arrangement with their hostess, otherwise they will swallow with their soup an amount sufficient for many generations of the drug: they may also safely order savoury rice, with browned veal and wine-sauce, which is evidently a strong point with the Cavalier. All meals there are picturesque; for the omelette

\* M. Thury found this hole, and fathomed it to a depth of 6½ mètres.

lay on the Castle of Grandson and a part of the Lake of Neufchatel, while the butter reposed on the ruined Cathedral of Sion, and the honey distilled pleasantly from the comb on to the walls of Wufflens. No one should put any trust in the spoons, which are constructed apparently of pewter shavings in a chronic state of semi-fusion. On the evening of the second day, the landlady allowed a second knife at tea, as the knife-of-all-work had begun to knock up under the heavy strain upon its powers; but this supplementary instrument was of the ornamental kind, and, like other ornamental things, broke down at a crisis, which took the form of a piece of crust.

Lest this account should raise anyone's expectations too high, it is as well to add that they have no snuffers in S. Georges, beyond such as Nature provided when she gave men fingers; and they burn attenuated tallow candles with full-bodied wicks. Also, the tea is flavoured with vanille, unless that precious flavouring is omitted by private contract.

### CHAPTER III.

#### THE LOWER GLACIÈRE OF THE PRÉ DE S. LIVRES.

I HAD intended to walk on from S. Georges to Bière, after returning from the glacière last described, and thence, the next morning, to the Pré de S. Livres, the mountain pasturage of the commune of S. Livres,\* a village near Aubonne. But Renaud advised a change of plan, and the result showed that his advice was good. He said that the *fermier* of the Glacière of S. Livres generally lived in S. Georges, and, if he were at home, would be the best guide to the glacière; while the distance from S. Georges was, if anything, rather less than the distance from Bière: so that by remaining at the Cavalier for another night the walk to Bière would be saved, and the possibility of finding no competent guide there would be evaded. Jules Mignot, the farmer in question, was at home, and promised to go to the glacière in the morning, pledging his word and all that he was worth for the existence and soundness of the ladders; a matter of considerable importance, for M. Thury had been unable to reach the ice, as also my sisters, by reason of a failure in this respect.

\* *Sancti Liberii locus*, the Swiss Dryasdust explains. 'There is nothing to connect any known S. Liberius with this neighbourhood, unless it be the Armenian prince who secretly left his father's court for Jerusalem, and was sought for throughout Burgundy and other countries. It seems that Saint Oliver is merely a corruption of S. Liberius, the Italian form of the latter, Santo Liverio, having become Sant-Oliverio, as S. Otho became in another country Sant Odo, and thence San Todo, thus creating a new Saint, S. Todus. —Act SS. May 27.

In the course of the evening Mignot came in, and confidentially took the other chair. He wished to state that he had three *associés* in working the *glacière*, and that one of them knew of a similar cave, half an hour from the one more generally known; the *associé* had found it two years before, and had not seen it since, and he believed that no one else knew where it was to be found. If I cared to visit it, the *associé* would accompany us, but there was some particular reason—here he relapsed into *patois*—why this other man could not by himself serve as guide to both *glacières*. As this meant that I must have two guides, and suggested that perhaps the right rendering of *associé* was ‘accomplice,’ the negotiation nearly came to a violent end; but the farmer was so extremely explanatory and convincing, that I gave him another chance, asking him how much the two meant to have, and telling him that, although I could not see the necessity for two guides, I only wished to do what was right. He expressed his conviction of the truth of this statement with such fervour, that I could only hope his moderation might be as great as his faith. He took the usual five minutes to make up his mind what to say, going through abstruse calculations with a brow demonstratively bent, and, to all appearance, reckoning up exactly what was the least it could be done for, consistently with his duty to himself and his family. Then he asked, with an air of resignation, as if he were throwing himself and his *associé* away, ‘Fifteen francs, then, would monsieur consider too much?’ ‘Certainly, far too much; twelve francs would be enormous. But, for the pleasure of his company and that of his friend, I should be happy to give that sum for the two, and they must feed themselves.’ He jumped at the offer, with an alacrity which showed that I had much under-estimated his margin in putting it at three francs; and with many

expressions of anticipatory gratitude, and promises of axes and ropes in case of emergency, he bowed himself out. The event proved that both the men were really valuable, and they got something over the six francs a-piece.

The rain had been steadily increasing in intensity for the last twenty-four hours, from the insidious steeping of a Scotch mist to the violence of a chronic thunderstorm, and had about reached this crisis when we started in the morning for the Pré de S. Livres. I had already tested its effects before breakfast, in a search for the Renaud of the day before, who had made statements regarding the ice at S. Georges, and the time of cutting it, which a night's reflection showed to be false. To search for Henri Renaud in the village of S. Georges, was something like making an enquiry of a certain porter for the rooms of Mr. John Jones. The landlady of the Cavalier was responsible for the first stage of the journey, asserting that he lived two doors beyond the next auberge, evidently with a feeling that it was wrong so far to patronise the rival house as to live near it. That, however, was not the same Henri Renaud; and a house a few yards off was recommended as a likely place, where, instead of Henri, a Louis Renaud turned up, shivering under the eaves in company with the *fermier*, who introduced Louis in due form as the accomplice. They received conjointly and submissively a lecture on the absurdity of calling it a rainy morning, and the impossibility of staying at home, even if it came on much worse, and then pointed the way to the true Henri Renaud, half-way down the village. When I arrived at the place indicated, and consulted a promiscuous Swiss as to the abode of the object of my search, he exclaimed, 'Henri Renaud? I am he.' 'But,' it was objected, 'it is the *marchand de bois* who is wanted.' 'Precisely, Henri Renaud, *marchand de bois*; it is I.' 'But, it is the cutter

of ice in the *glacière*.' 'Ah, a different Henri. That Henri is in bed in the house yonder,' and so at last he was found. When finally unearthed, Henri confessed that when he had said *spring* the day before, he ought to have said *autumn*, and that by autumn he meant November and December. Enquiries elsewhere showed that the end of summer was what he really meant, if he meant to tell the truth.

Our route for the *glacière* followed the high road which leads by the Asile de Marchairuz to La Vallée, as far as the well-known Châlet de la S. Georges; and then the character of the way changed rapidly for the worse, and we took to the wet woods. After a time, the wood ceased for a while, and a large expanse of smooth rock showed itself, rising slightly from the horizontal, and so slippery in its present wet condition that we could not pass up it. Then woods again, and then the *montagnes* of *Sous la Roche*, and *La Foireuse*, till at last, in two hours, the Pré de S. Livres was achieved. The fog was so dense that nothing could be seen of the general lie of the country; but the *thalweg* was a sufficient guide, and after due perseverance we came upon the *glacière*, not many yards from that line, on the north slope of the open valley, about 4,500 feet above the sea.

To prevent cattle from falling into the pit, a wall has been built round the trees in which it lies. The circumference of this wall is 435 feet, but there are so many trees at the upper end of the enclosure that this gives an exaggerated idea of the size of the pit. The men fed while the preliminary measurements were being made; and when this was accomplished, they pressed their bottle of wine upon me so hospitably that I was obliged to antedate the result which its appearance promised, and plead *mal d'estomac*. Of all things, it is most unwise to give a reason for a

negative, and so it proved in this instance; for they promptly felicitated themselves and me on the good luck by which it happened that they had brought a wine famous on all the côte as a remedy for that somewhat vague complaint—a homœopathic remedy in allopathic doses.

The glacière is entered by a natural pit in the gentle slope of grass, not much unlike the pit of La Genollière, but wider, and covered at the bottom with snow.\* The first ladder leads down to a ledge of rock on which bushes and trees grow, and this ledge it is possible to reach without a ladder; the next ladder leads on to the deep snow, and descent by any ordinary manner of climbing is in this case quite impossible.† The snow slopes down towards a lofty arch in the rock which forms the north-west side of the pit, and this arch is the entrance to the glacière; it is 28½ feet wide, and as soon as we passed under it we found that the snow became ice, and it was necessary to cut steps; for the surface of underground ice is so slippery, unlike the surface of ordinary glaciers, that the slightest defect

\* My sisters made a two-days' excursion from Arzier to this glacière in the autumn of 1862, and found no snow in the bottom of the pit. They took the route by Gimel to Bière, intending to defer the visit to the glacière to the morning of the second day; but being warned by the appearance known locally as *le sappeur qui fume*, a vaporous cloud at the mouth of a cavern near the Dent d'Oche, on the other side of the Lake of Geneva, they caught the communal forester at once, and put themselves under his guidance. The distance from Bière is two hours' good walking, and an hour and a half for the return. There was no ladder for the final descent, and the neighbouring chalet could provide nothing longer than 15 feet, the drop being 30 feet. Two Frenchmen had attempted to make their way to the cave a week before, but the old 30-foot ladder of the previous year broke under the foremost of them, and he fell into the pit, whence he was drawn up by means of a cord composed of rack-ropes from the chalet, tied together. However useful a string of cow-ties may be for rescuing a man from such a situation, A. and M. did not care to make use of that apparatus for a voluntary descent, so they were perforce contented with a distant view of the ice from the lower edge of the pit.

† See the section of this cave and pit on page 41.

from the horizontal makes the use of the axe advisable. The stream of ice falls gradually, spreading out laterally like a fan, so as to accommodate itself to the shape of the cave, which it fills up to the side walls; it increases in breadth from  $28\frac{1}{2}$  feet at the top to 72 feet at the bottom of the slope, and the distance from the top of the first ladder to this point is 177 feet. Here we were arrested by a strange wall of ice 22 feet high, down which there seemed at first no means of passing; but finding an old ladder frozen into a part of the wall, we chopped out holes between the upper steps, and so descended, landing on a flooring composed of broken blocks and columns of ice, with a certain amount of what seemed to be drifted snow. This wall of ice, which was 72 feet long and 22 feet high, was not vertical, but sloped the wrong way, caving in under the stream of ice; and from the projecting top of the wall a long fringe of vast icicles hung down, along the whole breadth of the fan. The effect of this was, that we could walk between the ice-wall and the icicles as in a cloister, with solid ice on the one hand and Gothic arcades of ice on the other, the floor being likewise of ice, and the roof formed by the junction of the wall with the top of the icicle-arcade. The floor of this cloister was not 22 feet below the top of the wall, for it formed the upper part of a gentle descending slope of ice, rounded off like a fall of water, which seemed to flow from the lower part of the wall; and the height of 22 feet is reckoned from the foot of this slope, which terminated at a few feet of horizontal distance from the foot of the wall. The wall of ice was plainly marked with horizontal bands, corresponding, no doubt, to a number of years of successive deposits; sometimes a few leaves, but more generally a strip of minuter débris, signified the divisions between the annual layers. There had been many columns of ice